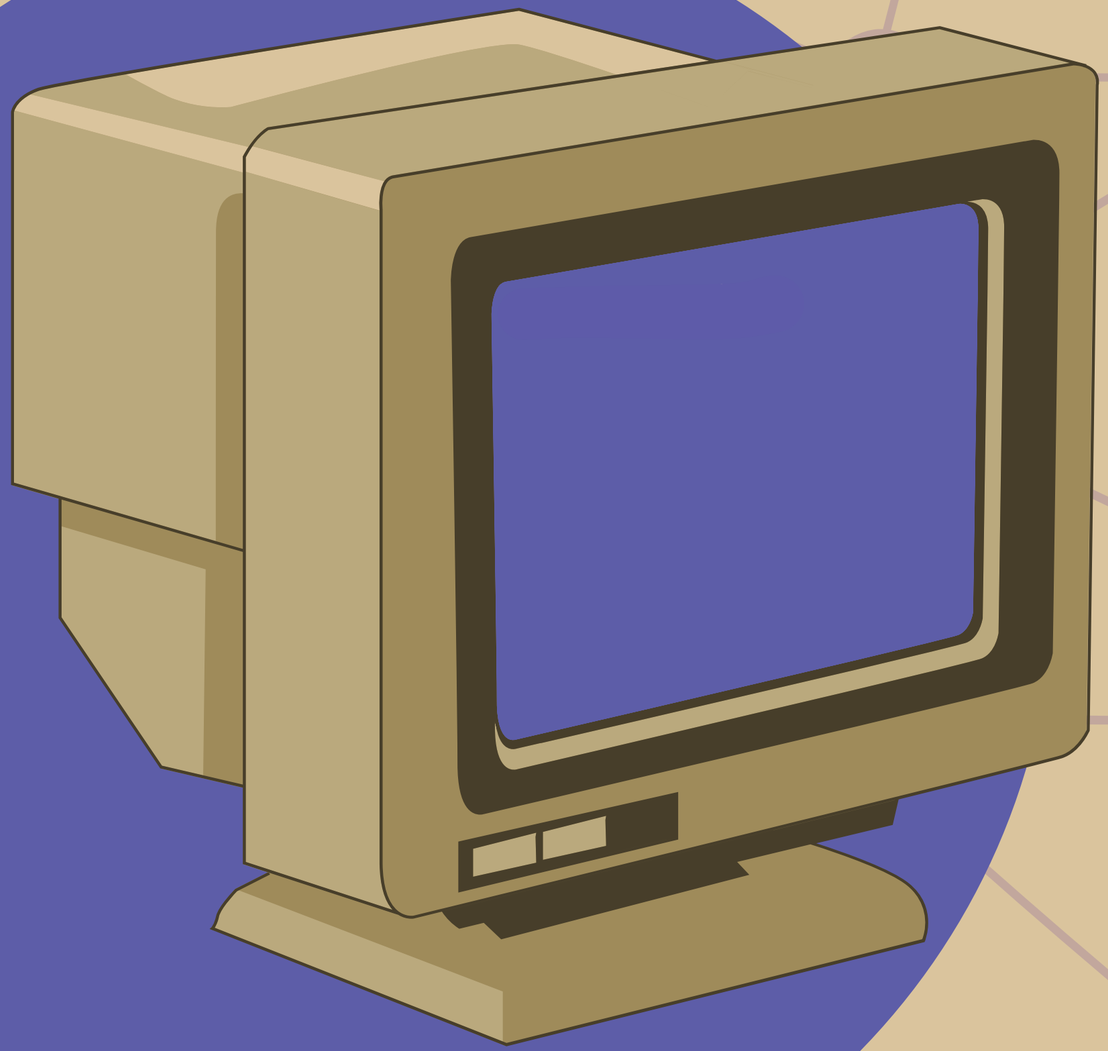


# COMPUTER NETWORKS

Ranges from smartwatch to phone network (PAN), Wi-Fi network at home connecting phones, laptops (LAN), TV cable network (MAN), & The Internet (WAN)

# WHAT IS A COMPUTER NETWORK?

A network is a collection of computers and devices that are connected together to enable communication and data exchange.

# Terminology to understand Networks

**Nodes :** Devices on a network that send, receive, or route data (e.g., computers, routers, IoT devices).

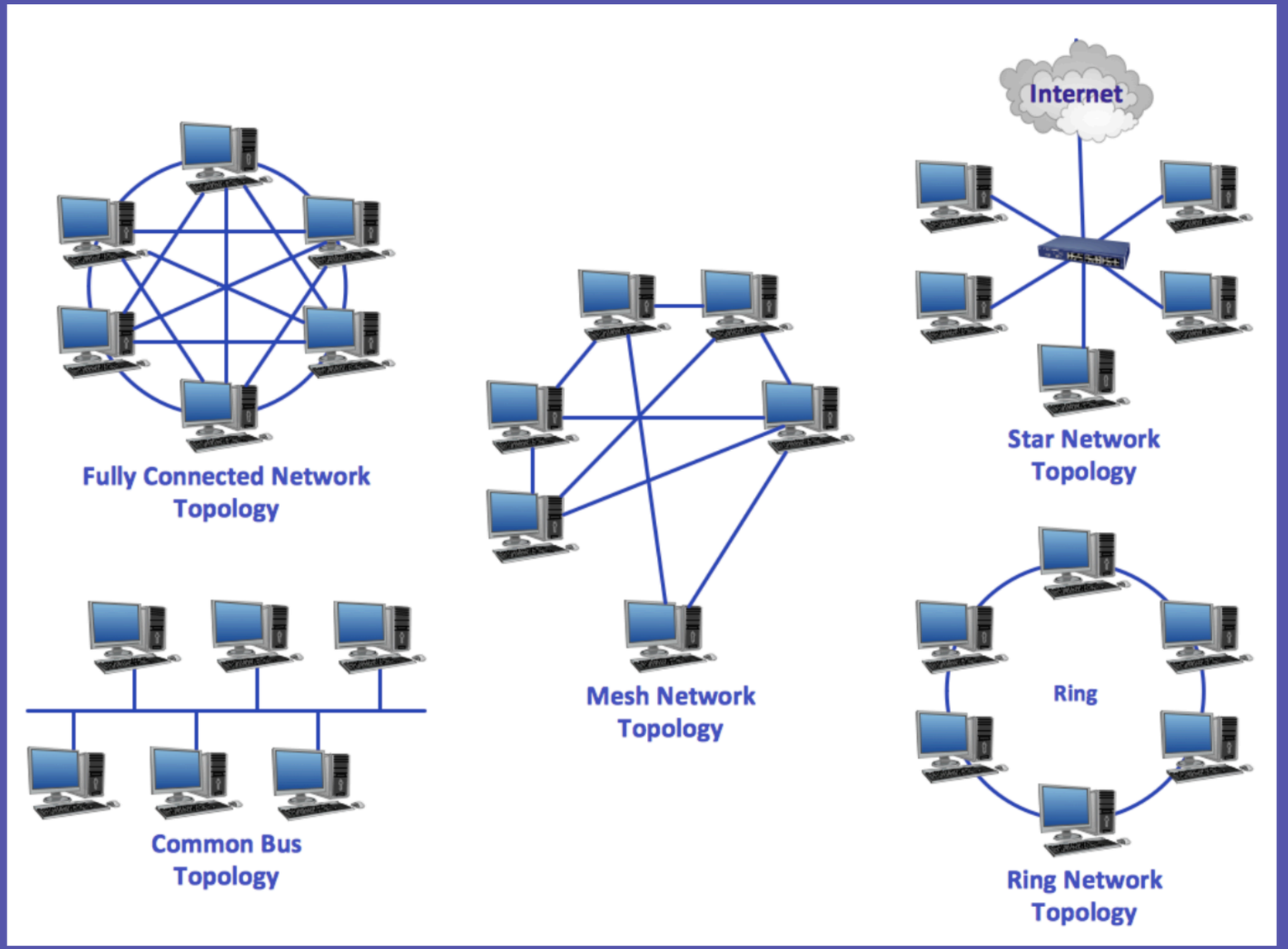
**Server:** A system that provides resources or services to other devices (clients) over a network.

**Topology:** The layout or structure of a network, like star, mesh, or ring.

**IP Address:** A unique identifier for a device on a network, like a digital address.

**Firewall:** A security system that monitors and filters network traffic to block harmful access.

# Topologies of different networks



# What is the Internet? How does it work?

**Internet = Huge global network of networks.**

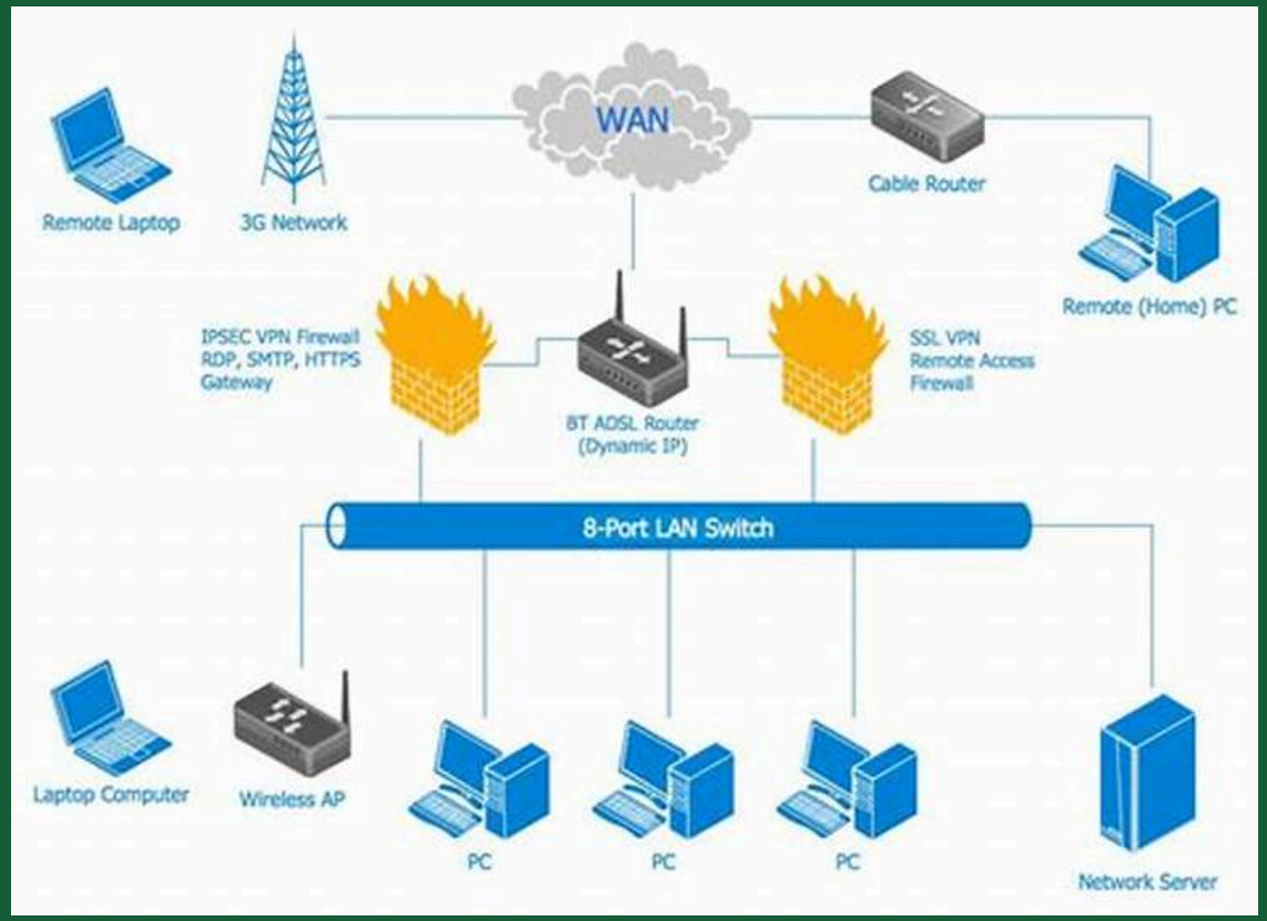
- Enables high-speed data communication between billions of devices.
- WWW (World Wide Web) is one part of the internet, where websites are linked like a web via URLs (like unique home addresses).

***How do we connect?***

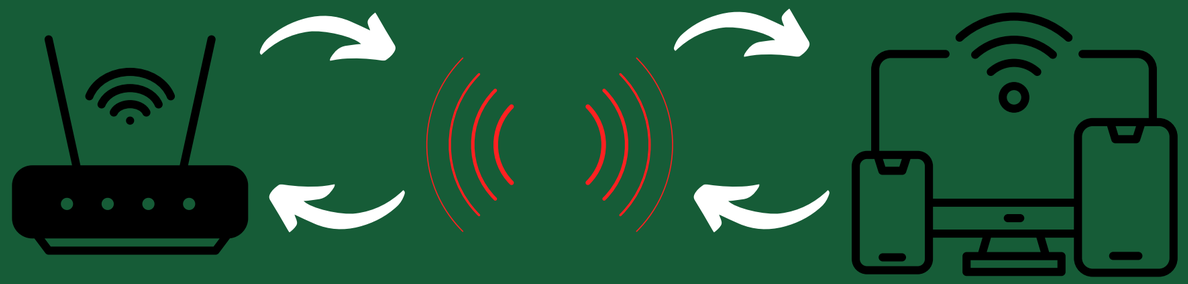
/SPs (Internet Service Providers) connect users to the internet. Use fiber optics, cables, towers, modems, and routers.

***How does data travel?***

Data travels in packets through various paths. Routers determine the fastest route from one device to another. Many possible routes ensure reliability and speed.

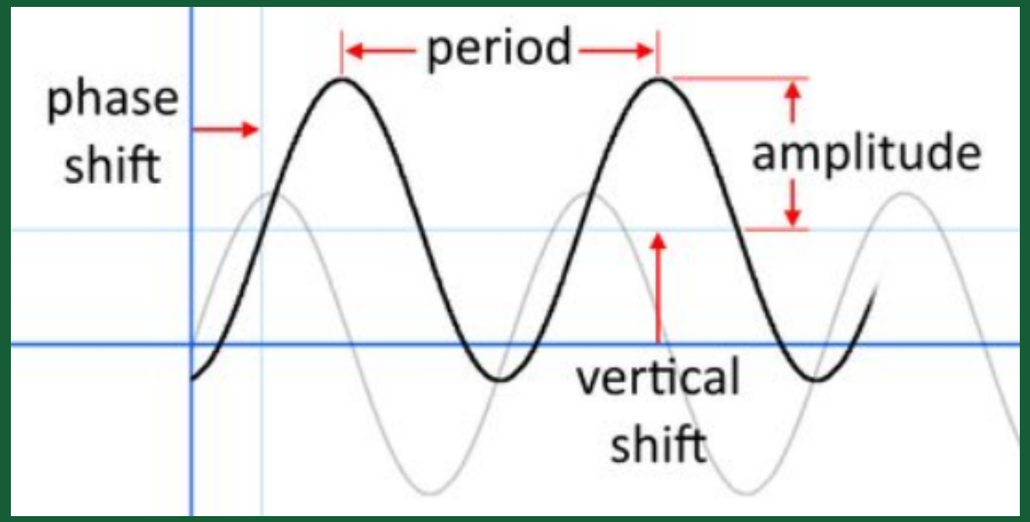


# What is Wi-Fi? How does it work?



**Wi-Fi = Wireless LAN that connects your devices (phones/laptops) to the internet.**

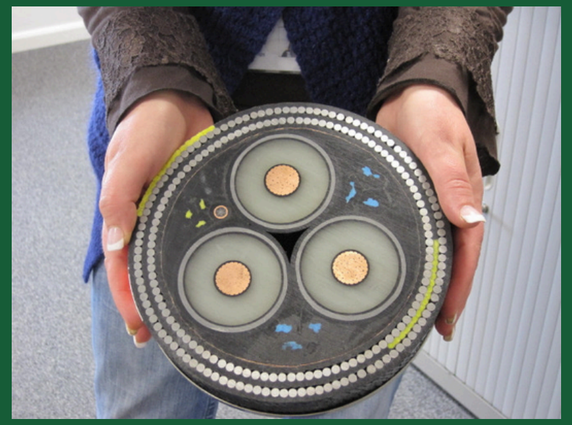
- Your Wi-Fi router, connected to the internet, receives data.
- Its Wi-Fi chip converts that data into radio signals.
- Your device's Wi-Fi chip receives the signals and turns them back into digital data.




ENCODING!!!
Remember your computer doesn't speak *Human?*
It speaks bits! 0s and 1s. Radio waves are electromagnetic waves. Our atmosphere does not speak either of *Human* or *Computer*.
It speaks waves!

***THINK*: how would you go about encoding a message into waves?**

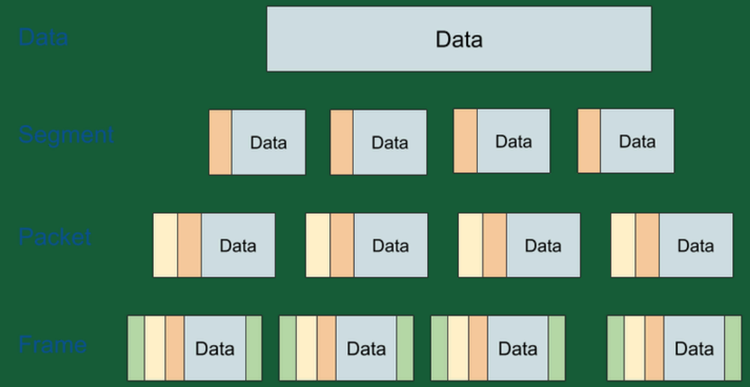
# Considerations:



Undersea cables would have to transmit huge amounts and multiple people’s data at the same time - how would this be achieved?

Data is converted into packets rather than being sent all in one go... why is that?

What are some internet protocols that you know of and why do you think they are needed?
IP, TCP, HTTPS, DNS, DHCP



# How does the Wi-Fi encoding work?

1. User: makes a request to the server for some information.
2. Phone’s wifi chip: encodes the request (in the form of bits) into electrical signal
3. Phone’s antenna: converts the electrical signal into radio waves.
4. This wave travels through the air in random directions and when it hits the antenna on a router, it induces a voltage (that is the radio wave is converted into electrical signal – hence the current), which passes to the wifi chip. there the wave is decoded into data.
5. the router then sends this data to the server, receives information, and does the same process to send the info to the phone!

**Cellular Data:**

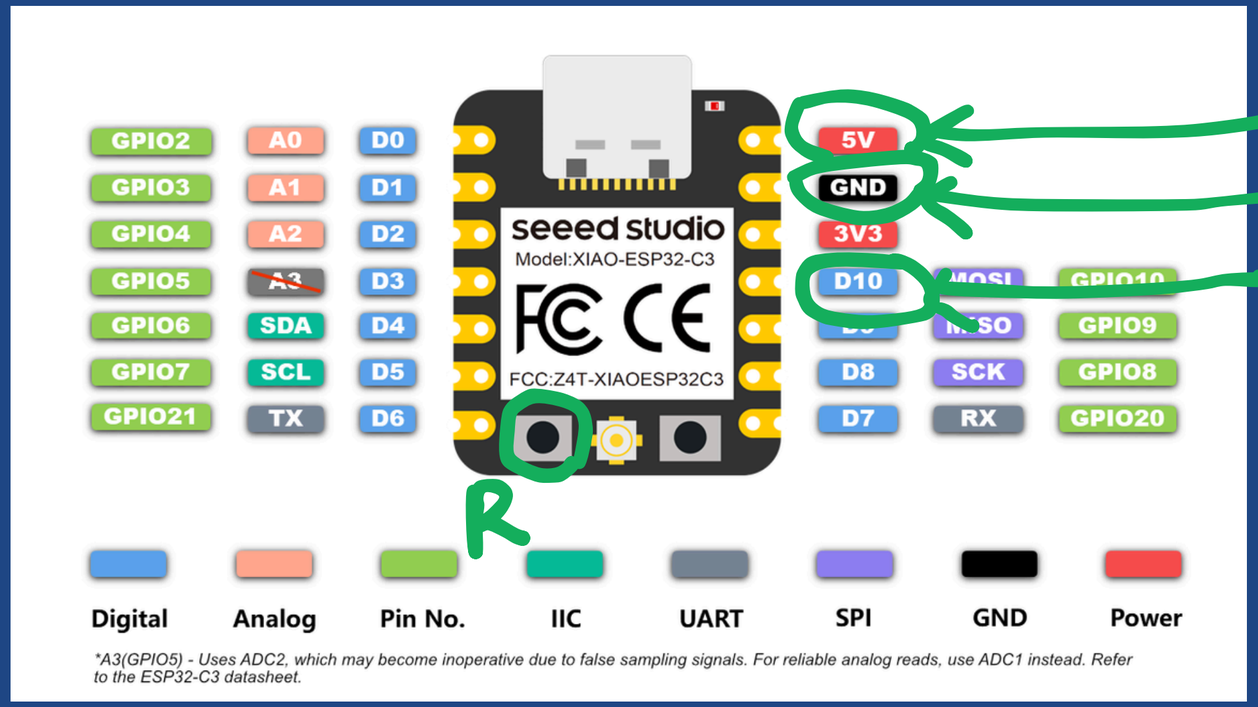
It’s similar to wifi but over a larger range and instead of exchanging signals with a router, you do that with a cell tower.

1. Your sim card is used as a means of personal identification to the mobile network.
2. Your phone communicates with the towers and exchanges signals.
3. once info reaches the tower, it sends the info the providers (carriers), after which it goes to mobile core network (sort of a control center for mobile network) and then connects to the public internet. Then the requests are made and provided with.

jio, airtel, bsnl, etc.

# What are ESPs and microcontrollers?

Espressif Systems' **microcontroller** boards, such as ESP32C3. These are low-cost, low-power Wi-Fi-enabled microcontrollers used for **Internet of Things (IoT) projects**.




+5V

blank/GND

Di

## WHAT ARE MICROCONTROLLERS?

A microcontroller is a small computer on a single chip designed to control electronic devices. It contains the core components of a basic computer, all packed into a compact integrated circuit (IC).

# How do ESPs form a network?

1. ESP devices find each other by broadcasting and listening.
2. On startup, an ESP sends a beacon and listens for others with the same mesh name, channel, and protocol.
3. When it detects a matching node, it connects and exchanges info like node IDs.
4. After this handshake, the ESP joins the mesh and can send, receive and relay messages

***THINK !!!*** 💡

**characteristics of the Mesh network that we are forming, is it:**

**centralized /decentralized?**

**self-healing/breaks when a single node drops?**

**direct messaging/everyone on path is informed?**

# What you may see and why

## \ysp-esp32-mesh-firmware\python-interface\src\lib

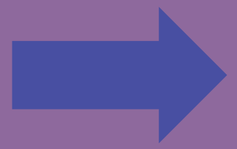
dir (in cmd), ls(in powershell)
to get this list of files

To run a partifular python file,
use the command:

**`python [file name].py`**

```
Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
d-----        26-05-2025     19:03                __pycache__
-a----        26-05-2025     17:49           3553 CommandParser.py
-a----        26-05-2025     17:49           7327 command_interface.py
-a----        26-05-2025     17:49            548 Config.py
-a----        26-05-2025     17:49           1971 DeviceList.py
-a----        26-05-2025     17:49           1508 Logger.py
-a----        26-05-2025     17:49           5053 main_controller.py
-a----        26-05-2025     17:49          11381 SerialController.py
-a----        26-05-2025     17:49          10011 wordlist
```

**duplicate the terminal/cmd window**



main_controller → gives us access into activity of the server

+

command_interface → gives you a list of commands to use/understand the network

# What you may see and why

**must run main_controller before command_interface**

on running main_controller

```
(.venv) C:\Users\91887\Documents\ysp-esp32-mesh-firmware\python-interfac
c\lib>python main_controller.py
ESP Connected: True, at port: COM7
Serial Number: 64:E8:33:80:AB:18, Node ID: 864070425, Hardware Index: 76
```

on running command_interface

```
(.venv) PS C:\Users\91887\Documents\ysp-esp32-mesh-firmware\python-interface
\src\lib> python command_interface.py
INFO: Command Interface initiated. Press CTRL+C or type "exit" to exit.
```

# Commands you can try

```
Enter a command
> gwsuh
Available Commands:
  get_topology                - Retrieve network topology
  ping_node                   - Send a ping to a node with optional color. Usa
ge: `ping_node [hw index] [color hex OR 'false']`
  print_my_nodeid             - Display the node ID of the development board c
onnected to your device
  print_payload               - Print the encrypted and plaintext payload sent
 in the previous `ping_node`
  export_topology             - Retrieve and save the current network topology
 to a JSON file `src/topology.json`
  help                        - Display this help message
  exit                        - Exit the command interface
```

type anything after running command_interface to be able to view all commands

to run a command, type out the exact command name. ex: get_topology

# constructing the network based on the topology result

```
[server] Sending command: get_topology
[serial] Received >>>
{
  "nodeId": 864070425,
  "subs": [
    {
      "nodeId": 2365950961
    },
    {
      "nodeId": 2365944825
    }
  ]
}
```

```
}
Node Count: 2
{
  "nodeId": 2652834468,
  "root": true,
  "subs": [
    {
      "nodeId": 3867414557,
      "subs": [
        {
          "nodeId": 2365951497
        }
      ]
    }
  ]
}
```

# Hardware IDs with corresponding names for Group 1

| | |
|---|---|
| Aaynn | 34 |
| Adwait | 23 |
| Aasiya | 33 |
| Nimaay | 35 |
| Neev | 36 |
| Nithya | 22 |
| Aastha | 30 |
| Anya | 28 |

refer to this when trying to ping a person. you and the person that you ping will have their ESPs light up.

# Hardware IDs with corresponding names for Group  2

| | |
|---|---|
| Aaynn | 34 |
| Adwait | 23 |
| Aasiya | 33 |
| Nimaay | 35 |
| Neev | 36 |
| Nithya | 29 |
| Aastha | 30 |
| Anya | 28 |

refer to this when trying to ping a person. you and the person that you ping will have their LEDPs light up.